CLAIMS

1. A device with tunable affinity for molecules, comprising:
    a. a substrate with a surface;
    b. a plurality of locally substantially parallel electrodes along said surface, such as about 0.3 nm to about 5 nm, each of said electrodes being connected to a tunable EMF source, such that a specific electrostatic environment perpendicular to said electrodes is created, extending along the electrodes, and providing a continuous binding area for molecules in contact with the binding area;

wherein by tuning the independently tunable EMF sources a specific affinity or repulsion is obtainable for molecules with specific electrostatic properties.

2. The device of claim 1, wherein adjacent electrodes are separated by a distance in the range of about 0.1 to about 10 nm, such as about 0.2 to about 8 nm, such as about 0.3 to about 5 nm, including about 0.5 to about 3 nm.

3. The device of claims 1 or 2, wherein the surface is formed perpendicular along the growth direction of alternately grown layers of insulating and conducting material.

4. The device of claims 1-2, wherein said surface is formed by an array of canisters penetrating at least one layer of alternating insulating and conducting material, in which the inner surface of said canisters forms said surface.

5. The device of any of the preceding claims, wherein the molecules are macromolecules.

6. The device of claim 5, wherein the macromolecules are selected from the group consisting of polypeptides, proteins and nucleic acids including DNA and RNA.

7. A method of isolating molecules based on their electrostatic properties, the method comprising:
    a. providing a substrate having a plurality of locally substantially parallel electrodes, each electrode being independently connected to a tunable EMF source;
    b. tuning said electrodes to individually selected potentials, thereby creating a specific electrostatic profile across the electrodes to generate a molecule-specific surface;
    c. contacting a medium comprising molecules with the substrate to allow binding of specific molecules having an affinity to said surface;

d. separating the medium from the substrate so as to separate the molecules bound to the substrate from non-binding molecules in the medium;
e. isolating said specific molecules by adjusting said EMF source to release by repulsion or by other means said molecules into a receiving medium brought in contact with the substrate..

8. The method of claim 7, further comprising the step of repeatedly releasing specifically bound molecules from said substrate into a receiving medium and subsequently bringing said substrate in contact with the medium containing molecules, so as to effectively remove specific molecules from the medium.

9. The method of claim 7, further comprising the step of detecting said binding molecules by observing the change in current through one or more of said electrodes.

10. The method of claim 9, wherein quantitative assessment for said binding molecules is obtained by comparing the current necessary to maintain the electrostatic configuration of the surface to the corresponding current obtained using samples with known concentration of molecules identical to said binding molecules.

11. The method of claim 7, further comprising the step of detecting said binding molecules by irradiating the molecule with light and measuring the conductivity of said molecules.

12. The method of claim 10, further comprising the step of measuring the conductivity of said binding molecules as a function of frequency of the light, thus generating a photo-conductance curve of said molecules.

13. The metod of claim 11, further comprising the step of quantitative determination of said binding molecules, by mapping photo-conductance curves for macromolecular species present in the sample to photo-conductance curves of samples of known concentration containing said macromolecular species.

14. The method of claim 7, further comprising the step of detecting said binding molecules by irradiating the molecules with pulsed light and measure the hopping conductance of said molecules.

15. The method of claim 14, further comprising the step of quantitative determination of said binding molecules, wherein the hopping conductance for the molecules is

compared to the hopping conductance of said molecules in a sample of known concentration.

16. A method of catalyzing chemical reactions between molecules comprising:
    a. providing a substrate having a plurality of locally substantially parallel electrodes, each electrode independently connected to a tunable EMF source;
    b. tuning said electrodes to individually selected potentials, thereby creating a specific electrostatic profile across the electrodes to generate a molecule-specific surface;
    c. contacting a medium comprising molecules with the substrate to allow binding of molecules specific for the chemical reaction and having an affinity to said surface;
    d. release of said molecules by adjustment of said EMF source into close spacial proximity of said surface;
    e. chemical reaction between said molecules accelerated by the increase in local concentration of said molecules.

17. The method of claim 16, further comprising the step of adjusting the EMF in substantially parallel electrodes in an adjacent fashion, so as to generate adjacent specific binding sites for molecules specific for the chemical reaction.

18. A method of separating molecules, comprising:
    a. providing a substrate having a plurality of locally substantially parallel electrodes, each electrode being independently connected to a tunable EMF source;
    b. tuning said electrodes so as to generate a non-specific electrostatic profile across the electrodes, thus generating a non-specific macromolecular surface;
    c. placement of a micro-channel along said surface;
    d. allowing a medium comprising molecules to pass through the micro-channel, thereby allowing separation of molecules according to their dipole moment.

19. The method of claim 18, wherein the tunable EMF is applied in a cyclic manner so as to generate a time-dependent non-specific macromolecular surface, thus allowing reversible non-specific binding to the surface

20. The method of claim 18, further comprising the step of detecting said molecules by applying a detection technique along said micro-channel distal to said surface, said technique being selected from the group consisting of UV spectrophotometry, circular

dichroism, fluorescence spectrophotometry, mass spectrometry, chemical potential, radioactivity.

21. The method of any of claims 7-20, wherein the molecules are macromolecules.

22. The method of claim 21. wherein the macromolecules are selected from the group consisting of polypeptides, proteins and nucleic acids including DNA and RNA.

23. A method of producing a device with tunable affinity for molecules, comprising :

a. growing a superlattice structure of alternate layers of electrically insulating and conducting materials;
b. cleaving or polishing the superlattice structure to obtain a surface essentially perpendicular to the growth direction of the superlattice structure;
c. connecting two or more of the conducting layers individually to tunable EMF sources, to obtain substantially parallel electrodes extending along said surface, which electrodes are individually or collectively tunable to a desired potential.

23. The method of claim 22, further comprising the step of forming an array of canisters penetrating at least one of said alternate layers of electrically insulating and conducting material.